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(54) **DISPLAY DEVICE**

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(52) **U.S. Cl.**
CPC **G02B 6/005** (2013.01); **G02B 6/0038** (2013.01); **G02B 6/0061** (2013.01); **G02B 6/0036** (2013.01); **G02B 6/0056** (2013.01); **G02B 6/0065** (2013.01); **G02B 6/0088** (2013.01)

(58) **Field of Classification Search**
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USPC 362/609, 634
See application file for complete search history.

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(57) **ABSTRACT**

A display device includes a display panel, a backlight unit configured to output light to the display panel, and a lens part interposed between the display panel and the backlight unit, and configured to transmit the light output from the backlight unit is transmitted, wherein the backlight unit includes an optical module configured to output the light, and a light guide plate configured to form a light path through which the light that is output from the optical module and incident on the light guide plate is transmitted and to scatter the incident light, the light guide plate including a fixing hole, a first pattern part configured to scatter the incident light output from the optical module, and a second pattern part provided adjacent to the fixing hole.

31 Claims, 10 Drawing Sheets

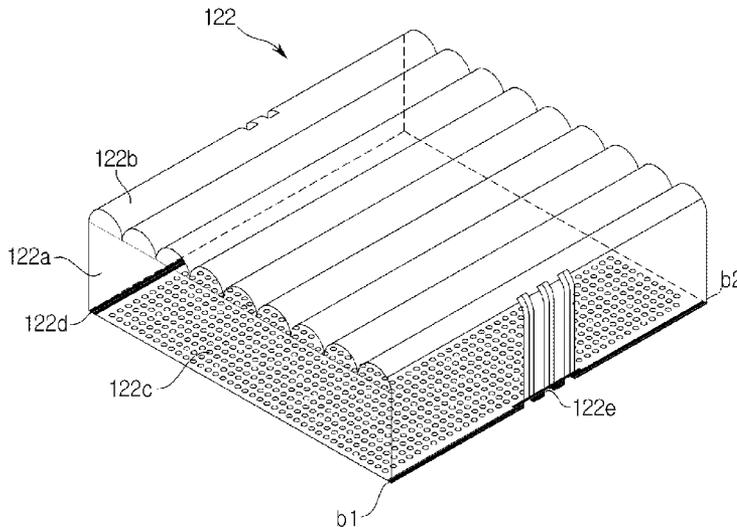


FIG. 1

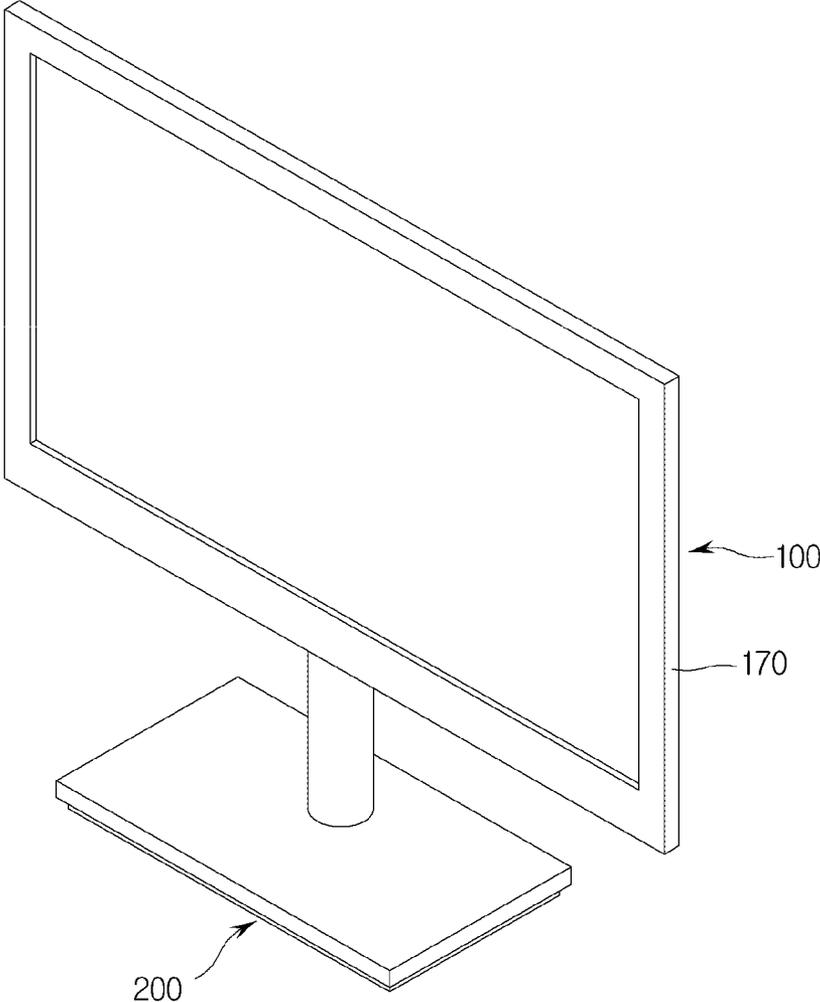


FIG. 2

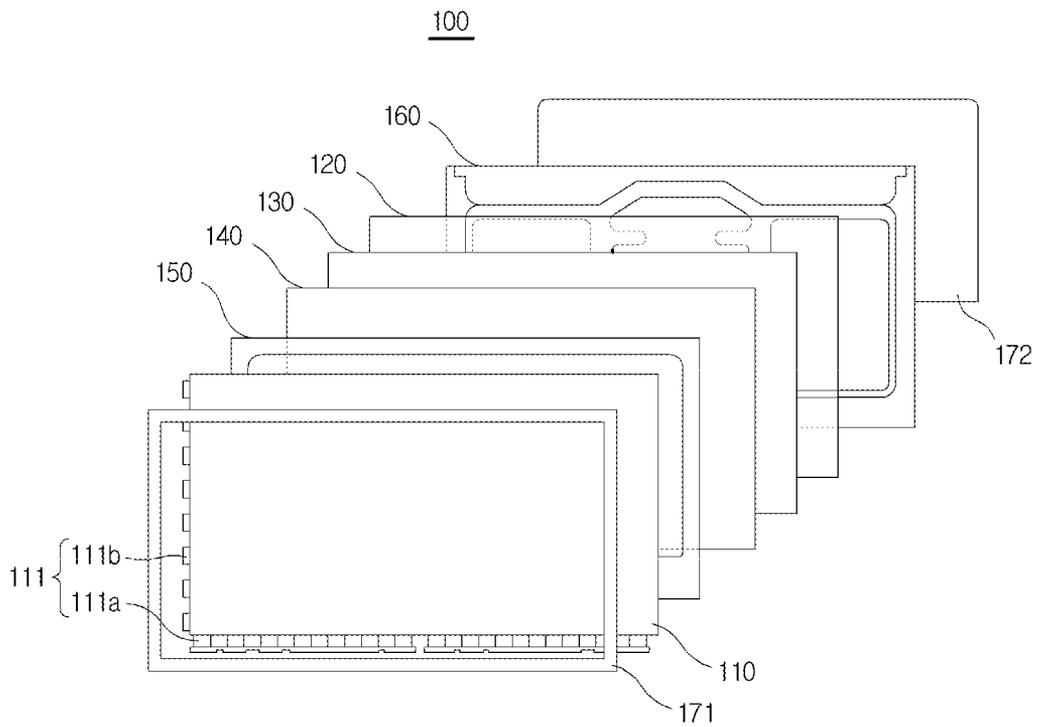


FIG. 3

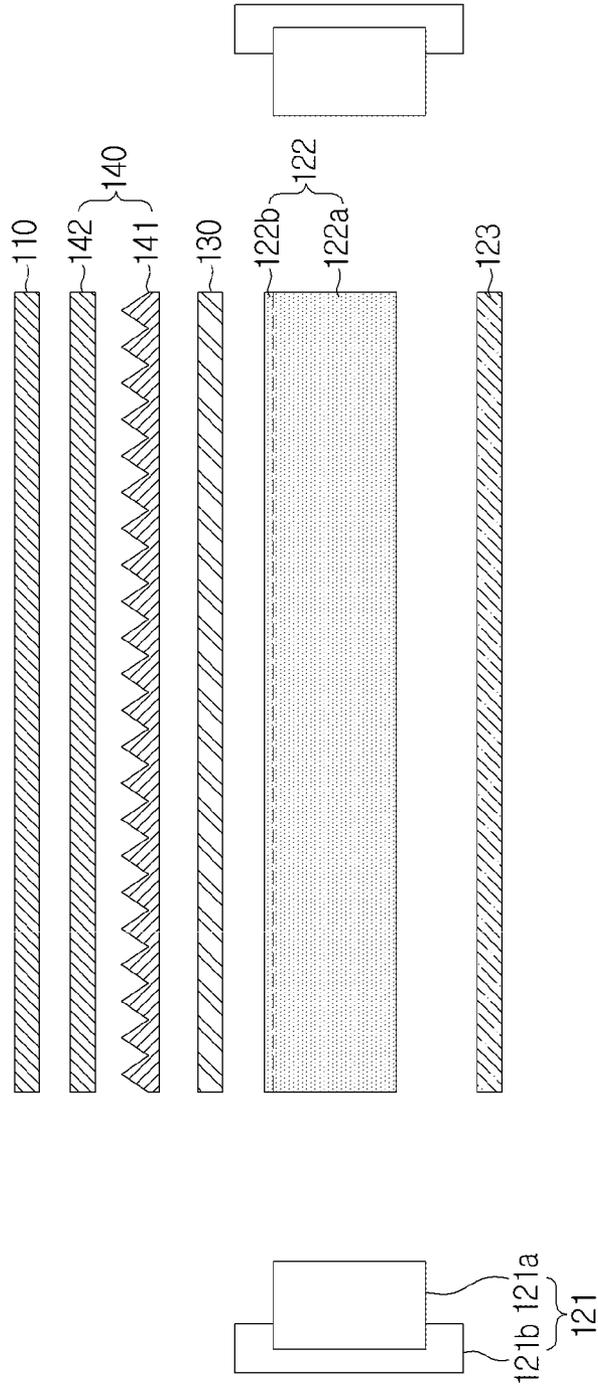


FIG. 4

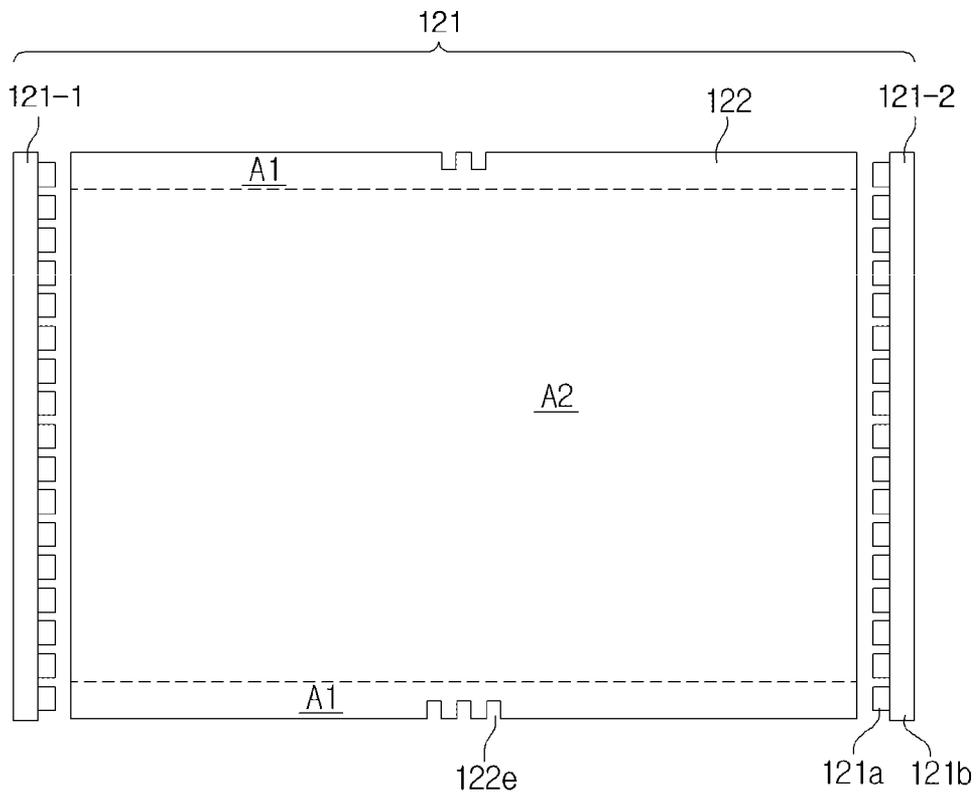


FIG. 5

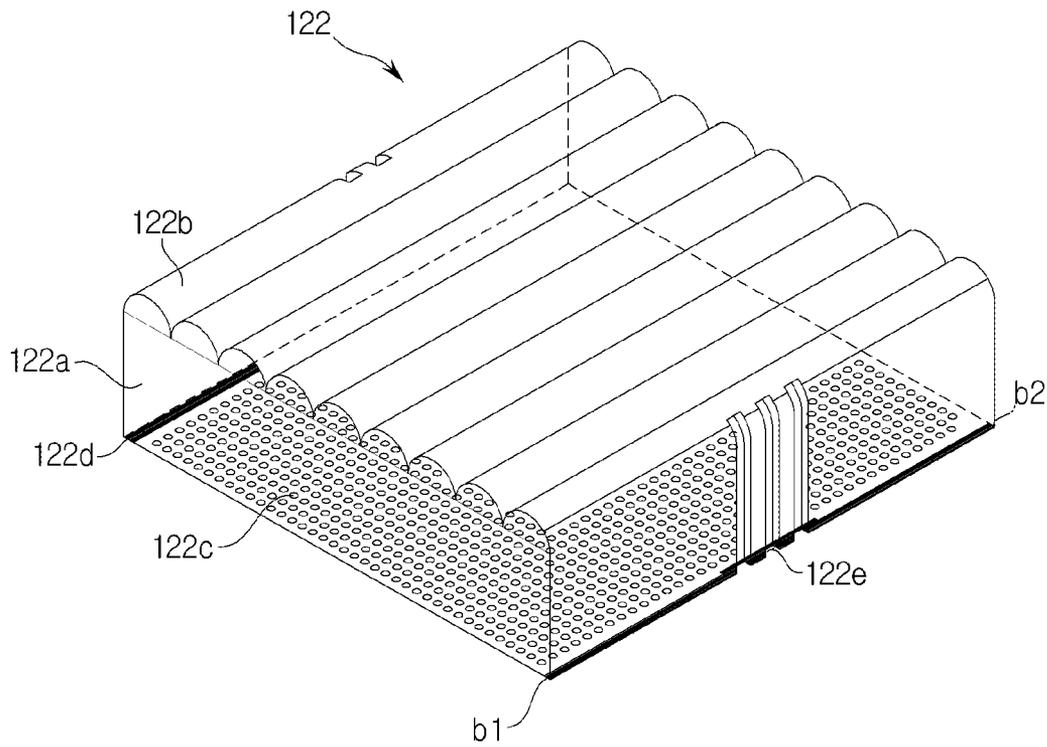


FIG. 6A

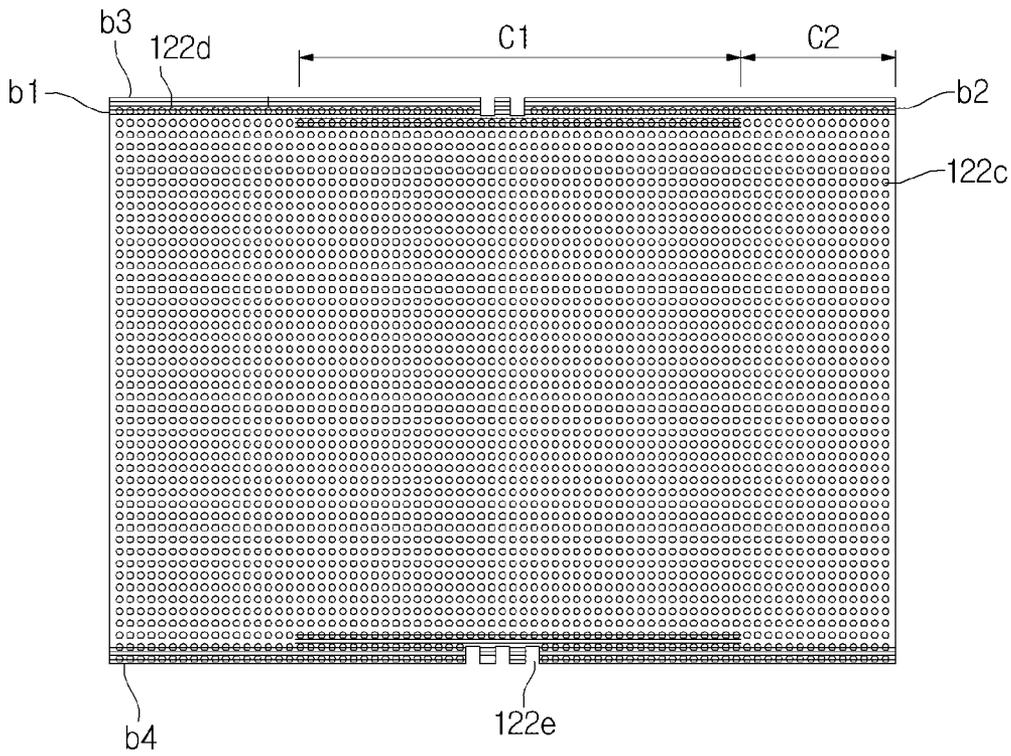


FIG. 6B

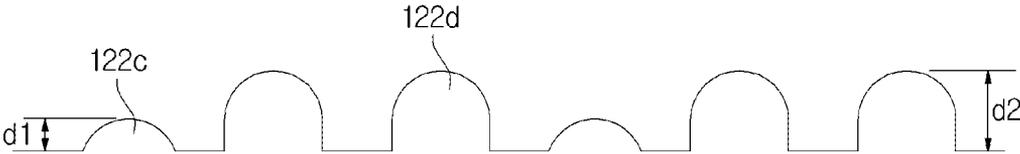


FIG. 7A

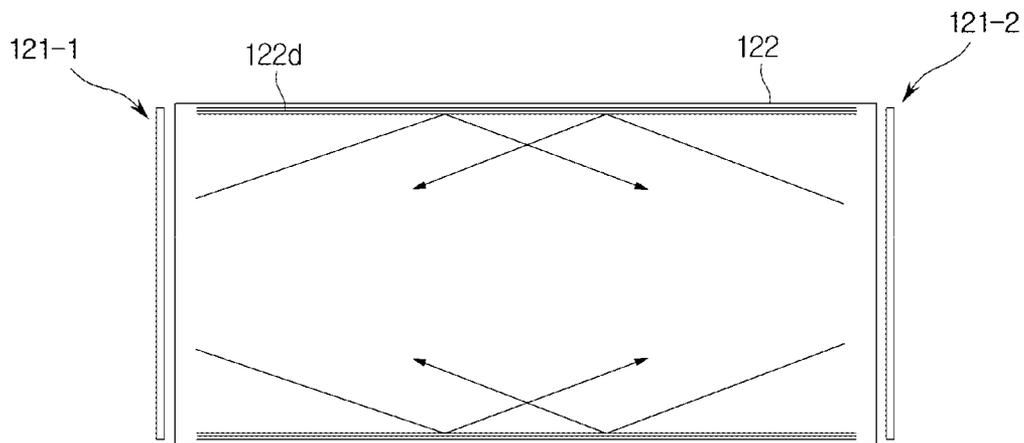


FIG. 7B

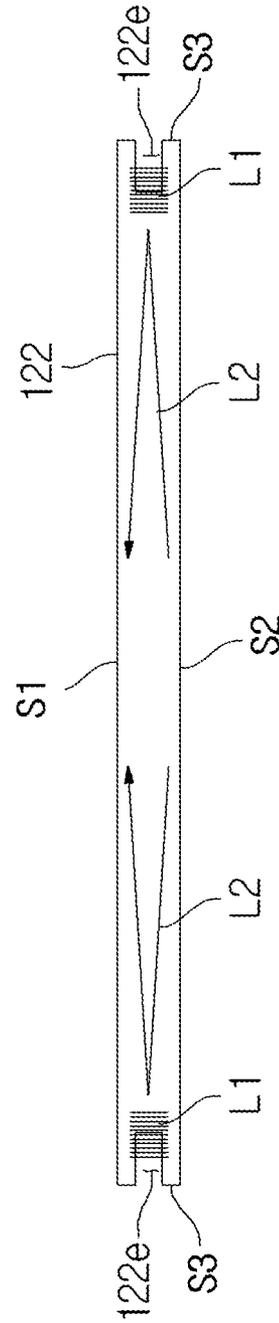
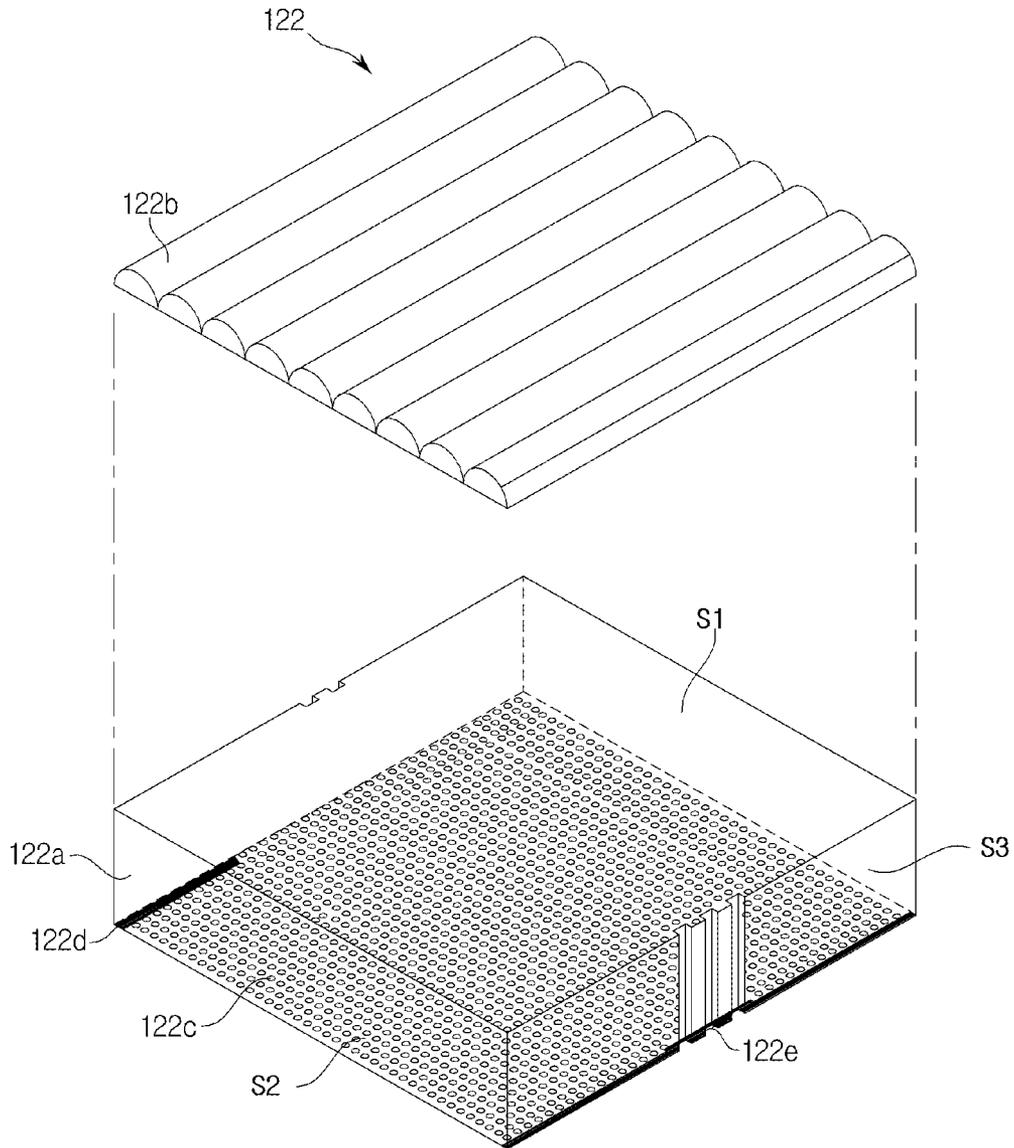


FIG. 8



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DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Korean Patent Application No. 10-2013-0058532, filed on May 23, 2013 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field

Apparatuses consistent with exemplary embodiments of the present disclosure relate to a display device having a light guide plate providing uniform brightness.

2. Description of the Related Art

In general, a display device is a device configured to display visual image information in a three-dimensional form.

In recent years, various types of flat panel display devices, including flat panel display devices which are less restricted in terms of the required installation space while also achieving thickness reduction and weight reduction, which are hard conditions to meet in a cathode ray tube display devices, are being developed. These flat panel display devices may also have other benefits, such as good representation of a large scale screen and flatness, and a high quality.

Representative examples of the flat panel display devices include a liquid crystal display (LCD), an electro-luminescence display (ELD), a field emission display (FED), a plasma display panel (PDP), a thin film transistor-LCD (TFT-LCD), and a flexible display.

Among these, the LCD is increasingly being used in various areas, such as a slim television, a slim monitor, and a slim portable display due to the low weight, low power consumption, and a thin thickness thereof.

A light receiving type flat panel display, such as an LED or a Light Box, is a display in which liquid crystals having properties between liquid and solid are injected between two glass panels having a thin thickness and the alignment of the liquid crystals is changed by supplying power to cause a contrast and display an image. Different from the PDP, FED, and organic ELD, the LCD is a non-emissive type element (a light receiving element), and thus requires an additional light emitting device for operation. Accordingly, there is a need for a backlight unit in the form of a surface light source capable of maintaining uniform brightness on the entire screen.

That is, the LCD displays an image by use of light emitted from a backlight unit.

The backlight unit may be a direct-type backlight unit having a light emitting device arranged at a lower surface of a liquid crystal panel to emit light from the light emitting device, or an edge-type light backlight unit having a light emitting device installed at one end of a light guide plate installed at a lower side of a liquid crystal panel to emit light from the light emitting device.

As a scanning technology is applied to the edge-type backlight unit, and a pattern having a prism shape or a lenticular shape is formed on an upper portion of a light guide plate of the backlight unit such that light travels straightforward, a high quality three-dimensional image is represented on the LCD.

Such an edge-type backlight unit has a shortcoming of a light bouncing phenomenon at a fixing hole formed in a light

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guide plate. In the conventional technology, in order to address such a light bouncing phenomenon, a black taping process is performed by attaching black tape to a surface having the fixing hole.

For this reason, an additional expense incurs due to purchasing the black tape, and the manufacturing process is complicated due to the taping process.

In addition, in the trend of developing larger scale display devices, the number of fixing holes is increased, and thus a region between the two fixing holes is blocked from light, making a dark portion. In addition, the straightforward path of light becomes difficult to achieve, and light bouncing occurs, so that the brightness of the light guide plate is less uniform.

SUMMARY

One or more exemplary embodiments provide a display device having a lens part formed on a first surface of a light guide plate and a double pattern part formed on a second surface of the light guide plate.

One or more exemplary embodiments also provide a display device having a straight line laser pattern processed at a region adjacent to a fixing hole of a light guide plate.

In accordance with an aspect of an exemplary embodiment, there is provided a display device including a display panel, a backlight unit, and a lens part. The backlight unit may be configured to output light to the display panel. The lens part may be interposed between the display panel and the backlight unit, and configured to transmit the light output from the backlight unit. The backlight unit may include an optical module and a light guide plate. The optical module may be configured to output the light. The light guide plate may be configured to form a light path through which the light that is output from the optical module and incident on the light guide plate is transmitted and to scatter the incident light, and may include a fixing hole, a first pattern part configured to scatter the incident light output from the optical module, and a second pattern part provided adjacent to the fixing hole.

The light guide plate may include a first region adjacent to the fixing hole and a second region excluding the first region such that light is scattered from the first region at an amount that is different than an amount that light is scattered from the second region.

The second pattern part may be configured to reduce an amount of light propagating toward the fixing hole from a light incident surface of the light guide plate adjacent to the optical module, to thereby prevent a light bouncing phenomenon at the fixing hole.

The first pattern part may be configured to scatter the incident light. The second pattern part may be configured to scatter, reflect and absorb light incident to the fixing hole.

The fixing hole may be provided on an edge of the light guide plate other than an edge adjacent to the optical module among a plurality of edges of the light guide plate.

The second pattern part may be a pattern provided along the edge having the fixing hole.

The first pattern part and the second pattern part may include depressions in a surface of the light guide plate. The depressions of the second pattern part may have a depth that is deeper than a depth of the depressions of the first pattern part.

The first pattern part and the second pattern part may be formed by laser processing.

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The first pattern part may include a plurality of dot type patterns. The second pattern part may include a plurality of straight line type patterns.

The second pattern part may include straight line type patterns having a density which increases from a light incident surface at which the light output from the optical module is incident toward a region adjacent to the fixing hole.

The second pattern part may be formed by performing the laser-processing at a speed slower than a speed at which the first pattern part is formed by performing the laser-processing.

The backlight unit may further include a reflector sheet configured to reflect the light output from the optical module toward the light guide plate.

The first pattern part and the second pattern part may be provided on a surface adjacent to the reflector sheet among surfaces of the light guide plate.

The display device may further include a prism sheet. The prism sheet may be disposed between the backlight unit and the display panel and may be configured to collect light output from the backlight unit.

The display device may further include a reflective polarizing sheet. The reflective polarizing sheet may be disposed between the backlight unit and the display panel and may be configured to reflect a portion of the light output toward the display panel and to transmit the reflected light toward the display panel.

The second pattern part may have an area that is larger than an area in which the fixing hole is depressed in the light guide plate.

In accordance with an aspect of another exemplary embodiment, there is provided a display device including an edge-type backlight unit including a light guide plate and an optical module. The light guide plate may include a base part, a lens part, a first pattern part and a second pattern part. The base part may include a first surface, a second surface opposite to the first surface, a plurality of lateral side surfaces surrounding the first surface and the second surface, and a fixing hole provided on a first lateral side surface among the plurality of lateral side surfaces, wherein the fixing hole may include a depression in the first lateral side surface and may extend from the first surface to the second surface, and the optical module may be disposed at a second lateral side surface among the plurality of lateral side surfaces. The lens part may be disposed on the first surface of the base part. The first pattern part may be provided on the second surface of the base part. The second pattern part may be provided at a region adjacent to the fixing hole, on the second surface of the base part.

The first lateral side surface may be different from the second lateral side surface. The second pattern part may include a straight line pattern provided at a periphery of the second surface adjacent to the first lateral side surface.

A length of the second lateral side surface is shorter than a length of the first lateral side surface.

The light guide plate may include a third lateral side surface opposite the first lateral side surface and a fourth lateral side surface opposite the second lateral side surface, and the fixing hole may be formed plurally in each of the first and third lateral side surfaces.

The plurality of fixing holes may be formed at center positions of each of the first and third lateral side surfaces and may be spaced apart from one another in the each of the center positions.

The second pattern part may be formed at edges adjacent to the first lateral side and the second surface and the third

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lateral side and the second surface, respectively, and may be formed to have a higher density in a region adjacent to the fixing hole compared to other regions of the light guide plate.

The first pattern part may be formed by moving a laser apparatus disposed adjacent to the second surface of the light guide plate at a first speed. The second pattern part may be formed by moving the laser apparatus at a second speed slower than the first speed.

The second pattern part may be formed at a first region of the light guide plate adjacent to the fixing hole formed in the light guide plate. The first pattern part may be formed at the first region and a second region of the light guide plate excluding the first region.

The second pattern part may be provided at a first region of the light guide plate adjacent to the fixing hole formed in the light guide plate. The first pattern part may be provided at a second region of the light guide plate excluding the first region.

The first pattern part may be configured to scatter light incident from the optical module. The second pattern part may be configured to scatter, reflect and absorb incident to the fixing hole and may form a light path for the light being incident from the optical module.

The second pattern part may be configured to reduce an amount of light propagating toward the fixing hole from a light incident surface of the light guide plate adjacent to the optical module, thereby preventing a light bouncing phenomenon at the fixing hole.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and/or other aspects will become apparent and more readily appreciated from the following description of exemplary embodiments, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a drawing illustrating an example of a display device in accordance with an exemplary embodiment;

FIG. 2 is an exploded perspective view illustrating the display device in accordance with an exemplary embodiment;

FIG. 3 is a cross sectional view illustrating the display device in accordance with an exemplary embodiment;

FIG. 4 is a plane view illustrating a backlight unit provided in the display device in accordance with an exemplary embodiment;

FIG. 5 is a perspective view illustrating a light guide plate of the backlight unit provided in the display device in accordance with an exemplary embodiment;

FIGS. 6A and 6B are bottom views illustrating the light guide plate of the backlight unit provided in the display device in accordance with an exemplary embodiment;

FIGS. 7A and 7B are drawings illustrating an example of a light path of a pattern part of the display device in accordance with an exemplary embodiment;

FIG. 8 is a perspective view illustrating a light guide plate of the backlight unit provided in the display device, illustrating another example of the light guide plate according to an exemplary embodiment.

DETAILED DESCRIPTION

Reference will now be made in detail to the exemplary embodiments, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to like elements throughout.

FIG. 1 is a drawing illustrating an example of a display device in accordance with an exemplary embodiment, FIG. 2 is an exploded perspective view illustrating the display device in accordance with an exemplary embodiment, and FIG. 3 is a cross sectional view illustrating the display device in accordance with an exemplary embodiment.

A display device **100** is a device configured to display an image, for example, a television, a monitor and a display device of a mobile communication terminal.

Referring to FIG. 1, the display device **100** displays an image and outputs sound. The sound may be output through an external device.

The display device **100** is supported by a stand **200** mounted at a lower end of the display device **100**, or may be installed on a wall by a bracket and the like.

In the following description in accordance with an exemplary embodiment, a liquid crystal display (LCD) will be described as an example of a display device that displays an image through a display panel by adjusting the amount of transmission of light emitted from a backlight unit without emitting light itself.

Referring to FIG. 2, the LCD **110** includes a display panel **110**, a backlight unit **120**, a diffuser plate **130**, optical sheets **140**, a support member **150**, a sash **160**, and a housing **170** (**171** and **172**). These elements will be described with reference to FIG. 3.

The display panel **110** is a panel configured to display image information, such as text, numbers, and icons, by adjusting transmittance of light passing through a liquid crystal layer. According to an exemplary embodiment, the display panel **110** may be a large scale panel having a size of about 60 inches, although it is understood that the display panel **110** may be larger or smaller than 60 inches according to other exemplary embodiments. The transmittance of light passing through the liquid crystal layer is adjusted by the intensity of voltage applied.

The display panel **110** includes a color filter panel, a thin film transistor array (TFT) panel **112** and a sealant **113**. According to an exemplary embodiment, each of the color filter panel and the TFT panel **112** is formed of glass. It is understood that the color filter panel and TFT panel **112** may be formed of other materials, e.g., plastic.

The color filter panel includes a red color filter, a green color filter and a blue color filter that are formed regions corresponding to respective pixel electrodes of the TFT panel **112**. In addition, a common electrode made of transparent conductive material, such as an Indium Tin Oxide (ITO) or an Indium Zinc Oxide (IZO), is formed on the color filter panel.

The TFT panel **112** of the display panel **110** is disposed to be spaced apart from the color filter panel, and includes a plurality of gate lines, a plurality of data lines and a plurality of pixel electrodes.

The gate lines are disposed in a row direction to transmit a gate signal, the data lines are disposed in a column direction to transmit a data signal, and the pixel electrode is connected to the gate line and the data line and includes a switching device and a sustain capacitor.

According to an exemplary embodiment, the switching device is formed at an intersection of the gate line and the data line, and the sustain capacitor has one terminal connected to an output terminal of the switching device.

The other terminal of the sustain capacitor is connected to a common voltage or the gate line.

The display panel **110** further includes a liquid crystal layer **114** disposed between the color filter panel and the

TFT panel **112**. The liquid crystal panel **114** includes sealing material and liquid crystals accommodated in the sealing material.

The liquid crystal layer **114** has an alignment direction changed according to a voltage applied to the outside, thereby adjusting transmittance of light passing through the liquid crystal layer **114**.

According to an exemplary embodiment, the color filter panel, the TFT panel **112** and the liquid crystal layer **114** of the display panel **110** form a liquid crystal capacitor in cooperation with one another, and the liquid crystal capacitor formed as such is connected to an output terminal and to a common voltage or a reference voltage.

The sealant **113** is formed at peripheries of the color filter panel and the TFT panel **112** of the display panel **110**, and serves to couple the color filter panel to the TFT panel **112**. The sealant **113** enables the display panel **110** to maintain its shape.

The display panel **110** further includes an image driver part **111**.

The image driver part **111** includes a first driver part **111a** driving an X-electrode, and a gate driver part **111b** driving a Y-electrode. The X-electrode is a source electrode, and the Y-electrode is a gate electrode. The first driver part **111a** and the second driver part **111b** are connected to a driving module (not shown).

The first driver part **111a** selects a gray scale voltage for each data line based on image data, and transmits the selected gray scale voltage to the liquid crystal through the data line.

The second driver part **111b** transmits an ON/OFF signal based on the image data to a thin film transistor (TFT), that is, a switching device, through a scan line, to turn on and off the TFT.

That is, if a voltage corresponding to each color value is supplied by the first driver part **111a**, the second driver part **111b** receives the voltage and connects the voltage to a corresponding pixel.

The source electrode is connected to the data line, the gate electrode is connected to the scan line, and a drain electrode of the TFT is connected to the pixel electrode. Such a TFT, when a scan signal is supplied to a scan line, is turned on and supplies a data signal from a data line.

A predetermined voltage is applied to the common electrode, and thus an electric field is formed between the common electrode and the pixel electrode. Due to the electric field, an alignment angle of the liquid crystal of the liquid crystal panel is changed, and based on the changed alignment angle, the light transmittance is changed such that a desired image is displayed.

The driving module (not shown) provides a gate drive signal and a data drive signal based on a data control signal and a data signal to the gate line and the data line formed on the TFT panel **112**, thereby implementing a desired image on the display panel **110**. This feature will be described in detail below.

The backlight unit **120** is a light source device configured to emit light from a lateral side of the display panel **110**, and represents an edge type LED light source device.

The backlight unit **120** includes a plurality of optical modules **121** (e.g., **121-1** and **121-2**), and a light guide plate **122** and a reflector sheet **123** that are disposed between the optical modules **121**.

Referring to FIG. 3, the optical module **121** includes a light source part **121a** configured to output light, and an optical driver part **121b** configured to drive the light source part **121a** to output light from the light source part **121a**.

According to an exemplary embodiment, the light source part **121a** may be a light emitting diode configured to emit light at a high efficiency and low power consumption. The optical driver part **121b** may be configured to block or adjust power being supplied to the light emitting diode, and may be implemented as a printed circuit board (PCB) having a plurality of light emitting diodes electrically mounted thereon.

The light guide plate **122** is configured to guide incident light to the display panel **110**. According to an exemplary embodiment, the light guide plate **122** is formed of plastic material, such as polymethylmethacrylate (PMMA) of a transparent acryl-based resin having light transmitting characteristics, or a polycarbonate (PC) based material in the form of a plate. It is understood that the light guide plate **122** may be formed of other plastic and non-plastic materials according to other exemplary embodiments.

Such a light guide plate **122** induces diffusion of light with a superior transparency, weather resistance, and colorability.

The reflector sheet **123** is disposed between the light guide plate **122** and the cover **172**, and reflects light provided at a lateral side surface of the light guide plate **122** toward a lateral side surface or toward a lens part **122b**.

Such an edge type backlight unit **120** will be described later in detail.

The diffusion plate **130** is a semi-transparent panel located between the display panel **110** and the backlight unit **120**, and is configured to diffuse light in the shape of a plane of the diffusion plate **130** such that color and brightness are seen to be uniform all over the screen. In this manner, the diffusion plate **130** improves the light emitted from the backlight unit **120** and supplies the light having the improved brightness to the display panel **110**.

That is, the diffusion plate **130** makes the light of the LED of the backlight unit **120** wider, and maintains the brightness of the entire surface of the diffusion plate **130** to be uniform.

The optical sheets **140** represent sheets disposed between the display panel **110** and the diffusion plate **130**, and include a prism sheet **141** having a prism formed thereon, and a reflective polarizing sheet **142**, for example, a dual brightness enhancement film (DBEF) coated in multilayer for double refraction.

The prism sheet **141** includes a prism pattern having a triangular prism shape, and the prism pattern is provided in a plurality thereof arranged adjacent to each other in the form of band shapes or some other type of shapes.

That is, according to an exemplary embodiment, the prism patterns **141** are arranged in columns while having a hill shape and a valley shape alternating with each other, protruding toward the display panel **110** from a reference surface.

In addition, the prism patterns of the prism sheet **141** are disposed to perpendicularly cross lens patterns of the lens part of the light guide plate **122**.

The reflective polarizing sheet **142** reflects some of the light that is to be absorbed by a polarizing plate (not shown) disposed at a front surface and a rear surface of the display panel **110**, and provides the reflected light to the polarizing plate again.

To be specific, the reflective polarizing sheet **142** allows some of the incident light to pass therethrough, and reflects the remaining light. The reflected light is recycled by the diffusion sheet **130** and the prism sheet **141** as scattering light, and some of the recycled scattering light passes through the reflective polarizing sheet **142** again and the

remaining portion thereof is reflected, thereby repeating such a recycling of light. As a result, the optical loss is minimized.

That is, the reflective polarizing sheet **152** recycles light that fails to pass through the polarizing plate, thereby enhancing the optical efficiency.

Such optical sheets **140** provide the display panel **110** with light having optical characteristics which are improved by enabling the brightness of light output from the light guide plate **122** to be uniform, and by diffusing light or collecting high brightness light.

The support member **150** supports the display panel **110**, the diffusion plate **130**, the optical sheets **140** and the sash **160** that are disposed between the bezel **171** and the cover **172**.

In addition, the support member **150** maintains a distance between the display panel **110** and the optical sheets **140**, a distance between the diffusion plate **130** and the optical sheets **140**, and a distance between the diffusion plate **130** and the backlight unit **120**.

The sash **160** is a panel configured to connect various components required for displaying an image and outputting sound, and has various types of printed circuit boards and input/output apparatuses mounted thereon.

Such a sash **160** is typically formed of metal having superior thermal resistance and strength, although is not limited to being formed of metal.

The sash **160** has a driving module (not shown) disposed thereon to drive the display panel **110** and the backlight unit **120**.

The housing **170** includes the bezel **171** and the cover **172**.

According to an exemplary embodiment, the bezel **171** forms a receiving space while being coupled to the cover **172**. The display panel **110**, the backlight unit **120**, the diffusion plate **130**, the optical sheets **140** and the sash **160** are disposed in the receiving space.

FIG. 4 is a plane view illustrating a backlight unit provided in the display device in accordance with an exemplary embodiment.

The first optical module **121-1** and the second optical module **12102** are disposed at two opposite lateral side surfaces of the light guide plate **122** of the backlight unit **120**, respectively, and a plurality of fixing holes **122e** are formed in the remaining opposite two lateral side surfaces.

The plurality of fixing holes **122e** are holes into which a screw or other fastening device may be inserted and coupled such that the light guide plate **122** may be fixed to the cover **172**.

That is, in order to stably fix the light guide plate **122** provided in a large scale to the cover **172**, for example, when the light guide plate **122** is 60 inches or larger, the fixing holes **122e** are formed in plural numbers in the light guide plate **122**.

Two or more of the fixing holes **122e** may be formed for each long edge. In this case, two or more fixing holes formed on one of the long edges are formed at the center of the long edge of the light guide plate **122** while being spaced apart from one another.

The light guide plate **122** includes a first region **A1** adjacent to the fixing hole **122e** and includes the opposite two lateral side surfaces on which the optical modules **121-1** and **121-2** are not disposed, and a second region **A2** which is a remaining portion of the light guide plate **122** excluding the first region **A1**.

Light output from the plurality of optical modules **121** (e.g., **121-1** and **121-2**) is incident onto the first region **A1** and the second region **A2** of the light guide plate **122**.

The light guide plate **122** further includes a pattern part provided plurally (e.g. in double) to prevent reflection from occurring on a boundary surface of the lateral side surfaces of the light guide plate **122**, on which the optical modules **121-1** and **121-2** are not disposed, while preventing the brightness of the first region **A1** from being represented to be different from the brightness of the second region **A2** due to the light bouncing and dark portion generated at a boundary surface forming the fixing holes **122e**. This feature will be described in detail with reference to FIG. 5.

FIG. 5 is a perspective view illustrating a light guide plate of the backlight unit provided in the display device in accordance with an exemplary embodiment. This light guide plate will be described in conjunction with FIGS. 6A and 6B and FIGS. 7A and 7B.

Referring to FIG. 5, the light guide plate **122** includes a base part **122a** and a lens part **122b** formed at one surface of the base part **122a**, and further includes a first pattern part **122c**, a second pattern part **122d** and the fixing hole **122e** that are formed at another surface of the base part **122a**.

According to an exemplary embodiment, the surface of the base part **122a** on which the first pattern part **122c** and the second pattern part **122d** are formed is an opposite surface to the surface on which the lens part **122b** is disposed.

The base part **122a** includes a first surface and a second surface corresponding to an upper surface and a lower surface, respectively, and lateral side surfaces including four lateral side surfaces surrounding the first surface and the second surface.

The lens part **122b** is formed on the first surface, which is the upper surface of the base part **122a**, and includes a plurality of lens patterns disposed adjacent to each other in the shape of bands. According to an exemplary embodiment, the plurality of lens patterns forms a plurality of valleys and a plurality of hills, and the hill is a rounded shape which protrudes toward the display panel **110** from the first surface.

Such a lens part **122b** collects light output from the first optical module **121-1** and the second optical module **121-2**, light reflected by the second surface, that is, the lower surface of the base part **122a**, and light reflected by the reflector sheet **123**, and provides the collected light to the display panel **110**.

According to an exemplary embodiment, the lens part **122b** may be integrally formed with the base part **122a**. That is, the lens part **122b** may be formed on the first surface of the base part **122a** through injection molding.

The first pattern part **122c** includes patterns that are formed on the entire regions **A1** and **A2** of the lower surface of the light guide plate **122** in a certain shape to supply uniform light to the display panel **110**.

According to an exemplary embodiment, the pattern of the first pattern part **122c** induces total reflection in a region adjacent to the first optical module and the second optical module, and induces scattering in the remaining region except for the region adjacent to the optical module.

Such a first pattern part **122c** may be formed by a laser processing, and embodied as various types, such as a dot pattern, a circular pattern, an elliptical pattern, a polygon pattern, and a hologram pattern.

The pattern may be formed on the second surface, that is, the lower surface of the light guide plate **122**, through a printing scheme or injection molding.

The second pattern part **122d** is formed on a periphery of the second surface adjacent to the remaining lateral side surfaces, except for the lateral side surfaces on which the optical modules are disposed, among the lateral side surfaces of the light guide plate **122**.

That is, the second pattern part **122d** is formed on the second surface, that is, the lower surface of the light guide plate **122**, at the first region **A1** having the fixing hole **122e** formed thereon so as to scatter some of the incident light, thereby preventing the light bouncing from occurring on the boundary surface forming the fixing hole **122e** and further preventing the dark portion from being generated between the adjacent fixing holes.

Such a second pattern part **122d** may be formed by laser processing, and includes straight line patterns that extend from a first edge **b1** to a second corner **b2** on the first region **A1**, the straight line patterns being arranged from a third edge **b3** to a fourth edge **b4** (third edge **b3** and fourth edge **b4** also being referred to as long edges) connecting the first edge **b1** to the second edge **b2**.

That is, according to an exemplary embodiment, the first pattern part and the second pattern part are formed by inwardly depressing the second surface of the light guide plate **122** by a laser processing.

Referring to FIG. 6A, more of the straight line patterns of the second pattern part **122d** are formed in a center portion **C1** having the fixing hole **122e** than in a region **C2** adjacent to the first edge **b1** and the second edge **b2** (first edge **b1** and second edge **b2** also being referred to as short edges).

That is, the straight line patterns of the second pattern part **122d** are concentrated on the center portion **C1** having the fixing hole **122e**.

The straight line pattern of the second pattern part **122d** formed in the center portion **C1** is spaced apart from the third edge **b3** towards the inner side of the light guide plate **122** by a predetermined distance that is greater than a distance by which the fixing hole **122e** is inwardly depressed from the third edge **b3**.

In addition, the straight line pattern of the second pattern part **122d** formed in the center portion **C1** is formed at a position spaced apart from the fourth edge **b4** towards the inner side of the light guide plate **122** by a predetermined distance that is greater than a distance by which the fixing hole **122e** is inwardly depressed from the fourth edge **b4**.

That is, the second pattern part **122d** has an area larger than a formation region of the fixing hole **122e** inwardly depressed from the light guide plate **122**, and thereby accommodates the formation region of the fixing hole **122e**.

Referring to FIG. 6B, the first pattern part and the second pattern part are formed by inwardly depressing the second surface of the light guide plate **122**, and in this exemplary embodiment, the first pattern part **122c** has a depth **d1** different from a depth **d2** of the second pattern part **122d**.

That is, the second pattern part **122d** has the depth **d2** which is deeper than the depth **d1** of the first pattern part **122c**. According to an exemplary embodiment, the depth **d2** of the second pattern part **122d** is about 1 mm, although is not limited thereto according to other exemplary embodiments.

In addition, the first pattern part and the second pattern part formed on the second surface of the light guide plate **122** may be formed as a double pattern in an overlapping manner. That is, the second pattern part may be formed on the first pattern part.

As described above, the first pattern part is formed on the first region and the second region of the second surface of the light guide plate **122**, and the second pattern part is

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formed on the second region such that the amount of light introduced to the fixing hole **122e** is reduced through the double pattern of straight lines, thereby reducing the amount of light dispersed at the fixing hole **122e**. In addition, the light bounced at the fixing hole **122e** is moderated by the light scattering that occurs due to the straight line double pattern. Through such a configuration, the brightness of the light guide plate **122** is provided to be uniform.

Hereinafter, the process of achieving a uniform brightness of the light guide plate **122** will be described with reference to FIGS. **7A** and **7B**.

FIG. **7A** is a drawing illustrating a light path when viewed from an upper side of the backlight unit according to an exemplary embodiment, and FIG. **7B** is a drawing illustrating a light path when viewed from a lower side of the backlight unit according to an exemplary embodiment.

Referring to FIG. **7A**, the straight line pattern of the second pattern part at the long edge serves to block and scatter light that is introduced from the optical module disposed at the short edge, to reduce the amount of light travelling toward the fixing hole **122e**, thereby improving the light bouncing at the fixing hole **122e**.

In this manner, the light absorbed by the straight line pattern of the second pattern part generally moderates the light bounced at the fixing hole **122e**. That is, the straight line pattern of the second pattern part prevents the light bouncing phenomenon at the fixing hole **122e** by scattering light.

Referring to FIG. **7B**, light **L1** at the first region adjacent to the fixing hole **122e** represents light absorbed and scattered by the straight line pattern of the second pattern part, and light **L2** at the second region represents light reflected by the straight line pattern.

In addition, the light guide plate prevents a bright line from being generated by having the straight line patterns formed at a higher density in the region adjacent to the fixing hole than the light incident surface onto which light is incident. Through such a configuration, a large amount of light is prevented from being reflected and scattered by the straight line pattern at the region adjacent to the light incident surface.

As described above, the light transmission path is guided, and thus the light leakage and light bouncing are canceled, thereby improving the image quality of a three dimension image.

Hereinafter, a method of forming the first pattern part **122c** and the second pattern part **122d** will be described.

The light guide plate **122** having the lens part **122b** formed on the first surface thereon is disposed on a stage (not shown). The light guide plate **122** is disposed so as to have the first surface thereof come into contact with a surface of the stage while having the second surface thereof adjacent to a laser apparatus (not shown).

Thereafter, the laser apparatus (not shown) outputs laser light while moving at a first speed, thereby forming the first pattern part **122c** on the first region and the second region of the second surface of the light guide plate **122**.

Thereafter, after the forming of the first pattern part **122c** is completed, the laser apparatus (not shown) outputs laser light while moving at a second speed in the first region **A1** of the opposite two lateral side surfaces of the light guide plate **122** having the fixing hole **122e**, to form the straight line patterns of the second pattern part **122d** at the first region of the second surface of the light guide plate **122**, in particular, so as to be concentrated on the region having the fixing hole **122e**.

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According to an exemplary embodiment, the first speed is a speed higher than the second speed.

Alternatively, the second pattern part **122d** may be formed by moving the laser apparatus at a second speed in the first region, and then the first pattern part **122c** may be formed at the second region by moving the laser apparatus at a first speed. The first speed may be a speed higher than the second speed.

FIG. **8** is a drawing illustrating a backlight unit provided in the display device, illustrating another example of the backlight unit according to an exemplary embodiment.

The light guide plate **122** includes the base part **122a**, the lens part **122b** disposed on a surface of the base part **122a**, and the first pattern part **122c**, the second pattern part **122d** and the fixing hole **122e** that are formed on another surface of the base part **122a**.

The base part **122a** and the lens part **122b** are formed separately from each other while being disposed adjacent to each other.

The base part **122a** of the light guide plate **122** includes the first surface **S1**, the second surface **S2** and the lateral side surfaces **S3** surrounding the peripheries of the first surface **S1** and the second surface **S2**. The lateral side surfaces include four lateral side surfaces.

The base part **122a** includes the first pattern part **122c** and the second pattern part **122d** that are formed on the second surface **S2**, and the fixing hole **122e** formed on the lateral side surfaces **S3** while extending from the first surface **S1** to the second surface **S2**. According to an exemplary embodiment, the second surface **S2** having the first pattern part **122c** and the second pattern part **122d** formed thereon is provided at an opposite side to the lens part **122b**.

The lens part **122b** is disposed adjacent to the first surface **S1**, that is, the upper surface of the base part **122a**, and has a plurality of lens patterns arranged in the shape of bands adjacent to each other. The plurality of lens patterns forms a plurality of valley and hill shapes, and the hill shapes protrude from the first surface toward the display panel and are rounded.

The lens part **122b** collects light output from the first optical module **121-1** and the second optical module **121-2**, light reflected by the second surface, that is, the lower surface of the light guide plate **122**, and light reflected by the reflector sheet **123**, and provides the collected light to the display panel **110**.

The lens part **122b** is formed separately from the base part **122a**.

The first pattern part **122c** is formed on the entire regions **A1** and **A2** of the second surface, that is, the lower surface of the light guide plate **122**, and includes a pattern provided in a predetermined shape to provide the display panel **110** with uniform light.

According to an exemplary embodiment, the pattern of the first pattern part **122c** induces total reflection in the regions adjacent to the first optical module and the second optical module, and induces scattering in the remaining region except for the region adjacent to the optical modules.

Such a first pattern part **122c** is formed by laser processing, and may be embodied as various types of patterns, such as a circular pattern, an elliptical pattern, a polygon pattern, and a hologram pattern.

The pattern may be formed on the second surface, that is, the lower surface of the light guide plate **122**, through a printing scheme or injection molding.

The second pattern part **122d** is formed on the second surface, that is, the lower surface of the light guide plate **122**, at the first region **A1** having the fixing hole **122e** formed

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thereon so as to scatter the incident light, thereby preventing the light bouncing from occurring on the boundary surface forming the fixing hole 122e while preventing the dark portion from being generated between the adjacent fixing holes.

The second pattern part 122d includes straight line patterns that are formed by laser processing, and extend from the first edge b1 to the second edge b2 while being arranged from the third edge b3 to the fourth edge b4 that are long edges connecting the first edge b1 to the second edge b2.

As described above, the first pattern part and the second pattern part are formed on the light guide plate 122, thereby allowing the light to travel in a straightforward fashion and thus maximize the LED scanning effect.

As is apparent from the above description, according to exemplary embodiments, the light bouncing and light leakage of the light guide plate of the display device having the edge-type backlight unit are prevented by using a laser processing technology without attaching black tape or using a bezel for blocking light, thereby ensuring an easy manufacturing process, improving the productivity of the display device, and improving the quality of the product while reducing the unit cost of manufacturing the product.

In addition, according to exemplary embodiments, the light incident onto the display panel may have a uniform brightness, and the displaying of three-dimensional content may be improved.

Although a few exemplary embodiments have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these exemplary embodiments without departing from the principles and spirit of the disclosure, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A display device comprising:
 - a display panel;
 - a backlight unit configured to output light to the display panel; and
 - a lens part interposed between the display panel and the backlight unit, and configured to transmit the light output from the backlight unit,
 wherein the backlight unit comprises:
 - an optical module configured to output the light; and
 - a light guide plate configured to form a light path through which the light that is output from the optical module and incident on the light guide plate is transmitted and to scatter the incident light, the light guide plate comprising:
 - a fixing hole;
 - a first pattern part configured to scatter the incident light output from the optical module; and
 - a second pattern part provided adjacent to the fixing hole and comprising straight line patterns,
 wherein more of the straight line patterns of the second pattern part are formed in a center portion of the light guide plate having the fixing hole than in a region of the light guide plate horizontally extending from the center portion to an edge of the light guide plate.
2. The display device of claim 1, wherein the light guide plate has a first region adjacent to the fixing hole and a second region excluding the first region such that light is scattered from the first region at an amount that is different than an amount that light is scattered from the second region.
3. The display device of claim 1, wherein the second pattern part is configured to reduce an amount of light propagating toward the fixing hole from a light incident

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surface of the light guide plate adjacent to the optical module, to thereby prevent a light bouncing phenomenon at the fixing hole.

4. The display device of claim 1, wherein:
 - the first pattern part is configured to scatter the incident light; and
 - the second pattern part is configured to scatter, reflect and absorb light incident to the fixing hole.
5. The display device of claim 1, wherein:
 - the fixing hole is provided on an edge of the light guide plate other than an edge adjacent to the optical module among a plurality of edges of the light guide plate; and
 - the second pattern part is a pattern provided along the edge having the fixing hole.
6. The display device of claim 1, wherein:
 - the first pattern part and the second pattern part comprise depressions in a surface of the light guide plate; and
 - the depressions of the second pattern part have a depth that is deeper than a depth of the depressions the first pattern part.
7. The display device of claim 6, wherein the first pattern part and the second pattern part are formed by laser processing.
8. The display device of claim 7, wherein:
 - the first pattern part comprises a plurality of dot type patterns; and
 - the second pattern part comprises a plurality of straight line type patterns.
9. The display device of claim 8, wherein the second pattern part comprises straight line type patterns having a density which increases from a light incident surface at which the light output from the optical module is incident toward a region adjacent to the fixing hole.
10. The display device of claim 7, wherein:
 - the second pattern part is formed by performing the laser-processing at a speed slower than a speed at which the first pattern part is formed by performing the laser-processing.
11. The display device of claim 1, wherein the backlight unit further comprises a reflector sheet configured to reflect the light output from the optical module toward the light guide plate.
12. The display device of claim 11, wherein the first pattern part and the second pattern part are provided on a surface adjacent to the reflector sheet among surfaces of the light guide plate.
13. The display device of claim 1, further comprising:
 - a prism sheet disposed between the backlight unit and the display panel and configured to collect light output from the backlight unit.
14. The display device of claim 1, further comprising:
 - a reflective polarizing sheet disposed between the backlight unit and the display panel and configured to reflect a portion of the light output toward the display panel and to transmit the reflected light to the display panel.
15. The display device of claim 1, wherein the second pattern part has an area that is larger than an area in which the fixing hole is depressed in the light guide plate.
16. A display device comprising an edge-type backlight unit comprising a light guide plate and an optical module, wherein the light guide plate comprises:
 - a base part comprising a first surface, a second surface opposite to the first surface, a plurality of lateral side surfaces surrounding the first surface and the second surface, and a fixing hole provided on a first lateral side surface among the plurality of lateral side surfaces, wherein the fixing hole comprises a depression in the

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first lateral side surface and extends from the first surface to the second surface, and the optical module is disposed at a second lateral side surface among the plurality of lateral side surfaces;

a lens part disposed on the first surface of the base part; 5
a first pattern part provided on the second surface of the base part; and
a second pattern part provided at a region adjacent to the fixing hole, on the second surface of the base part.

17. The display device of claim 16, wherein: 10
the first lateral side surface is different from the second lateral side surface; and
the second pattern part comprises a straight line pattern provided at a periphery of the second surface adjacent to the first lateral side surface.

18. The display device of claim 17, wherein a length of the second lateral side surface is shorter than a length of the first lateral side surface. 15

19. The display device of claim 18, wherein the light guide plate comprises a third lateral side surface opposite the first lateral side surface and a fourth lateral side surface opposite the second lateral side surface, and a plurality of the fixing holes is formed in each of the first and third lateral side surfaces. 20

20. The display device of claim 19, wherein the plurality of fixing holes are formed at center positions of each of the first and third lateral side surfaces and are spaced apart from one another in the each of the center positions. 25

21. The display device of claim 20, wherein the second pattern part is formed at edges adjacent to the first lateral side and the second surface and the third lateral side and the second surface, respectively, and is formed to have a higher density in a region adjacent to the fixing hole compared to other regions of the light guide plate. 30

22. The display device of claim 16, wherein:
the first pattern part is formed by moving a laser apparatus 35
disposed adjacent to the second surface of the light guide plate at a first speed; and
the second pattern part is formed by moving the laser apparatus at a second speed slower than the first speed.

23. The display device of claim 16, wherein: 40
the second pattern part is provided at a first region of the light guide plate adjacent to the fixing hole formed in the light guide plate; and

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the first pattern part is provided at the first region and a second region of the light guide plate excluding the first region.

24. The display device of claim 16, wherein:
the second pattern part is provided at a first region of the light guide plate adjacent to the fixing hole; and
the first pattern part is provided at a second region of the light guide plate excluding the first region.

25. The display device of claim 16, wherein:
the first pattern part is configured to scatter light incident from the optical module; and
the second pattern part is configured to scatter, reflect and absorb light incident to the fixing hole and form a light path for the light output from the optical module.

26. The display device of claim 25, wherein the second pattern part is configured to reduce an amount of light propagating toward the fixing hole from a light incident surface of the light guide plate adjacent to the optical module, thereby preventing a light bouncing phenomenon at the fixing hole.

27. A light guide plate comprising:
a top side, a bottom side opposite the top side, and lateral sides connecting the top side to the bottom side;
a hole formed in one of the lateral sides; and
depressions formed in an inward direction on the bottom side,
wherein a first group of the depressions is formed on the lateral side having the hole, a second group of the depressions is formed in a region excluding the lateral side having the hole, and the depth of the first group of the depressions is deeper than the depth of the second group of the depressions.

28. The light guide plate of claim 27, further comprising a lens part formed on the top surface.

29. The light guide plate of claim 28, wherein a surface of the lens part is shaped to include a plurality of valleys and a plurality of hills between the plurality of valleys.

30. The light guide plate of claim 29, wherein the lens part is integrally formed with the top surface.

31. The light guide plate of claim 29, wherein the lens part is detachably attached to the top surface.

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